ENGINEERING EDUCATION

Bulletin of the

Society for the Promotion of Engineering Education

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TABLE OF CONTENTS.

Foreword. Chas. F. Scott, President of the Society 328
The University of Illinois—A Land Grant College. Rexford Newcomb 331
The Need for Measurement in Engineering Education. J. Crosby Chapman 348
Discussion: From the Notebook of an Engineer—II. Ernest G. Beck 353
Freshman Civil Engineering Course at the University of Nebraska. Wm. H. Pahl 358
The California Institute of Technology—Its Aims and Purposes ... 365
Report of Branches 367
College Notes 375
Book Reviews 380
Conference of Teachers of English to Engineering Students 383

FOREWORD.*

BY CHAS. F. SCOTT,
President of the Society.

Engineering Education may be treated under two heads:

1. The objects which we are aiming to accomplish. These may be indicated in the form of questions. What is the ideal output of our colleges? What should be the college training of the engineer?

2. The means and methods useful for accomplishing these objects? What should be the personnel and qualifications of teachers? What should be the content of courses? What should be the teaching means and teaching methods employed?

The latter is primarily the problem for the teacher, therefore, the problem of our Society. We are to determine the best means and methods, and it is our function to raise the standards of teachers and of teaching. This has been a large factor in our annual meetings and in our publications, and it is now the definite object of our branch meetings.

The question as to what the graduate should be, however, is a question in which the engineering profession which he is to enter and the industries which he is to serve are vitally concerned. It is for the user of engineering graduates to indicate the type of men which the profession needs. The user and producer should agree upon the specifications which are to be met.

The problem, therefore, is one in which engineering societies and the industries should be brought into active relation with our Society.

*Editor's Note: I am sure it will be of interest to members to know that Professor Chas. F. Scott as President of the A. I. E. E. was the originator of the idea of sections and branches of engineering societies in this country.

This classification may be suggestive in considering and planning for the future of the Society. My active contact with the Society during the past year, both in preparation for the New Haven meeting and as President since, convinces me that there are great needs in engineering education. A large and broadened activity by the Society may be a very important factor in meeting these needs. In a recent bulletin I asked along what lines and in what way the Society should proceed to enlarge its activities and its usefulness. The growth and development of the branches and section of the Society give promise in solving some of our most important problems.

The first active movement towards local organizations in our engineering societies was by the A. I. E. E. The number of local organizations formed during the first six months was 17. (There are now over 100.) During the present year there have been 27 local groups formed in the S. P. E. E., indicating a really gratifying rate of growth of the local organization movement in the Society. The total membership of the A. I. E. E., when local organizations were inaugurated, was approximately the same as that of our Society at present.

One of the large opportunities of our Society is the bringing together of teachers of non-engineering subjects with teachers of engineering subjects. The specific way of doing this at Yale has been the exposition of the teaching of physics to engineers by the department of physics and the proposed meeting in which the department of mathematics will give a similar exposition.

My present object is to encourage members to give their views, especially their constructive views, with regard to the future of the Society.

You may be interested in two letters which I recently received. One letter from an eminent professor who had remarked that the Society was not worth the powder to blow it up, replied to a request for constructive criticism, that the real trouble with engineering teachers was the mediocre per-

sonnel of the teachers themselves; that branch meetings for the consideration of methods of teaching were of little use, as mediocre men could never become good teachers; that the solution was to get better teachers, that this required money and that he knew of no way to get the money. As the writer is an old-time friend and somewhat of a pessimist, his statement did not frighten me.

The other letter presents another point of view which all should seriously consider.

"At the conclusion of your 'Foreword' in the January number of ENGINEERING EDUCATION you ask the question 'What is the reaction of engineering teachers to the proposal that the Society for the Promotion of Engineering Education should take an active leadership in the larger development of engineering education.' Based upon the past history of the Society, particularly as it relates to the participation by the Society in the Mann report on engineering education, I believe the Society for the Promotion of Engineering Education is incapable of assuming an active leadership. It seems to me that we must look to the engineers in practice and not to the teachers for any very far-reaching work on this problem. Reasoning by analogy from the transformations in medical education wrought by the American Medical Association, my judgment is that we must look to the national engineering societies, and particularly to the Federated American Engineering Societies, for the leading part in any advance in engineering education."

Has he taken the right position? Will others kindly send me their views?

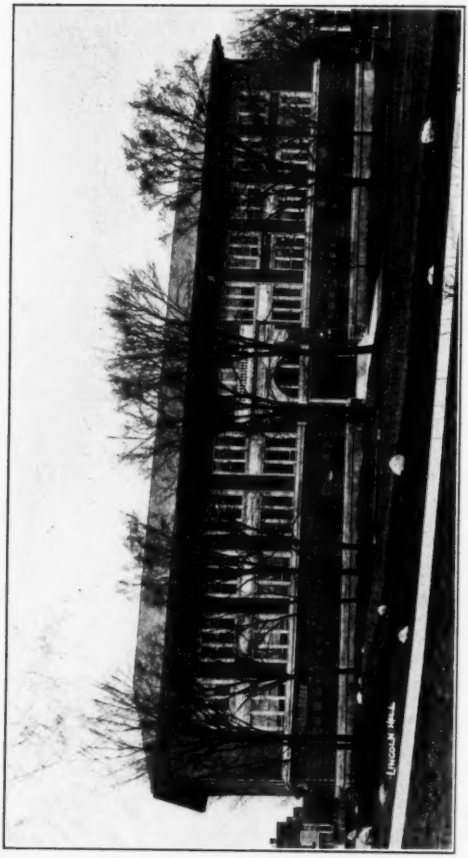
THE UNIVERSITY OF ILLINOIS—A LAND-GRANT COLLEGE.

BY REXFORD NEWCOMB,

Professor of Architectural History.

The University of Illinois throughout its history has been inseparably linked with the progress of ENGINEERING EDUCATION in America. Originating at a time when the need for industrial training for American youth was only beginning to dawn upon the public mind, the fight for its establishment was intimately bound up with the land-grant movement which has made possible, in a great measure, the triumphant progress of industrial education and the existence of a large group of institutions performing the important function of training the engineer. In view of this fact and the further fact that the SOCIETY will hold its annual meeting at Illinois, it would seem not inappropriate that the story of the development of this institution—one of the great land-grant colleges—be recalled at this time.

The University of Illinois is situated in the twin-cities of Urbana and Champaign, 126 miles south of Chicago, 118 miles west of Indianapolis and 164 miles northeast of Saint Louis. Although the University is officially situated in the city of Urbana, the campus lies almost midway between the business centers of the two cities and occupies territory within the corporate limits of each. So closely allied with the University, its life and activities are these municipalities that they form to all intents and purposes one community of some thirty thousand inhabitants. They enjoy the same public utilities, bear almost identical relationships to the University, are separated only by an imaginary line down one street, but persist, for reasons more historic than valid, as separate and distinct corporations.



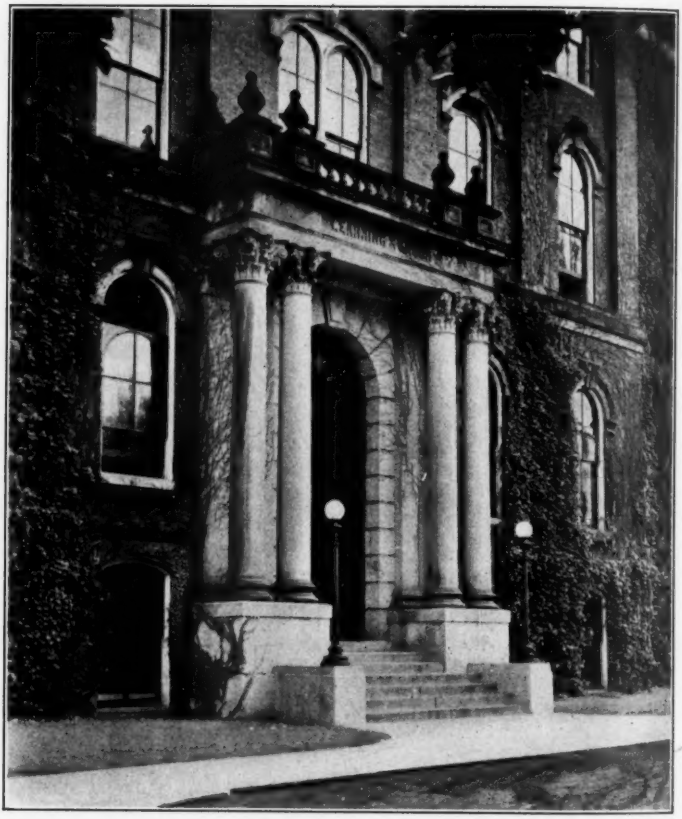
Lincoln Hall—University of Illinois.

The "Twin-Cities" are served by three lines of steam railroad and the Illinois Traction System (electric). From Chicago and points north or south visitors to the University should arrive at Champaign by the Illinois Central Railroad which is the main line between Chicago and New Orleans. There are excellent and frequent trains to and from Chicago. The Peoria and Eastern Division of the "Big Four" Railroad serves both cities and connects at Indianapolis with lines east (Pittsburgh, Philadelphia, Washington, New York) and at Bloomington and Peoria with lines west (Kansas City), while the Wabash provides both cities a connection with the Saint Louis-Detroit-Buffalo line of that road. The Illinois Traction System connects neighboring Illinois cities and Saint Louis.

The "Twin-Cities," while they lie at the heart of the wealthy Illinois "Corn Belt" and form the business and social center of a rich farming community, are so completely dominated by the University with its nearly 10,000 students as to be in every sense college towns. The student is in evidence everywhere in term time while firm-names as well as the varieties of merchandise displayed in the shops indicate at all times the proximity of a great institution of learning.

Among the sisterhood of great universities Illinois is one of the youngest. This year marks the fiftieth anniversary of the first graduating class, and it is but fifty-four years since the institution opened its doors to the reception of students. Within the brief span of a half century the struggling "college upon the prairies" has grown in size, importance and influence to a point that justifies its mention among the first ten great American universities.

The University of Illinois grew out of that movement in favor of industrial education that swept our country in the first half of the last century and resulted in the establishment of many industrial and polytechnic institutes throughout the eastern half of the United States. Rensselaer Polytechnic Institute was founded in 1824; Oneida Institute of Science and Industry at Oneida, New York, was opened three years



Entrance to " Old Uni "—University Hall—University of Illinois.

later and many others of similar intention followed. The movement thus started in New York worked westward with the establishment of Oberlin College which opened as a "manual-labor college" in 1833, and with the founding of Knox Manual Labor College at Galesburg, Illinois, in 1838. For twenty years Oberlin, now universally recognized as a classical college, retained her manual-labor features and her students largely supported themselves. Knox College, also known as a college of liberal arts and sciences, was the outgrowth of Knox Manual Labor College, which was founded by Rev. George W. Gale, who after establishing Oneida Institute, had come west. McKendree College at Lebanon, Illinois, founded in 1826, seems to have had a manual-labor shop as early as 1836, thus satisfying the popular demand for coupling "learning with labor."

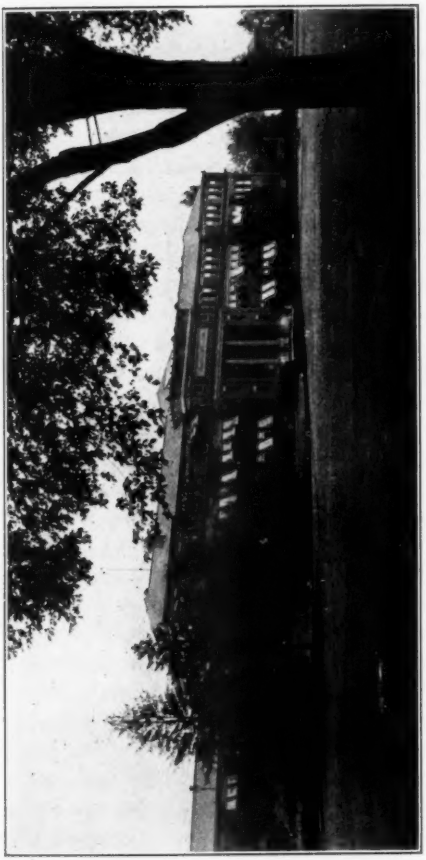
Thus although we see early attempts to provide general and even elementary technical education in Illinois, the movement for the establishment of a state university seems to have been particularly belated, especially when it is remembered that as early as 1802 the beginnings of what became later Ohio University at Athens were made and that in 1817 and 1820 respectively the legislatures of Michigan and Indiana had established the institutions that are now the universities of those states. There were perhaps many reasons for this delay, the most outstanding of which were the financial troubles that crippled the young state for a number of years directly following its admission to the Union in 1818. These troubles grew out of the failure of the First State Bank, the blundering state policy of internal improvements, the failure of the Second State Bank in 1842 and the attendant misappropriation of Federal funds, intended for the establishment of a state institution of learning, to help make up the resulting deficit in state funds. Thus the establishment of a state university did not come about until a much later date.

It must not be thought, however, that there were not frequent attempts to establish such an institution. As early as

1833 a bill was presented to the state legislature providing for the location of a state institution of learning at Springfield. Opposition from other jealous towns and antagonism from the small sectarian schools already in existence served effectively to defeat the bill. The next year Governor Ducan recommended the establishment of a state university but his recommendation was ignored. Moves of one sort or another were carried on with little success until about 1850 when Professor Jonathan Turner began his agitation for the establishment of a state-owned industrial and agricultural institution.

Professor Turner, a Yale-trained man, had come to Illinois as early as 1838 to become professor of English literature and rhetoric at Illinois College, a recently established institution at Jacksonville. His college maintained a farm and carpenter-shop where the students worked and kept in health while they earned money to partially defray their expenses. In 1847 he had resigned his professorship to devote his time to farming and fruit-raising and the next year began his activities to establish agricultural education in Illinois by engaging President Blanchard of Knox College upon the subject of the advisability of the establishment of a chair in agriculture. Making little headway in this direction he began two years later the formation of public opinion by addresses at teachers' institutes and took as his general theme the appeal for advanced education for farmers and mechanics. In his address at Griggsville on May 3, 1850, entitled "A Plan for a State University for the Industrial Classes" he pleaded in behalf of the workers for a "system of liberal education for their own class, and adapted to their own pursuits." He attacked the old classical institutions for their one-sided dependence upon books and advocated a scheme of learning that should in addition to the traditional studies offer instruction in all the sciences and arts and provide for original investigation and research in the fields of mechanics and agriculture.

The next year Buell Institute, a farmers' association of Central Illinois, offered Turner an opportunity to further



College of Agriculture—University of Illinois.

preach his gospel for the establishment of an "Industrial University." Subsequent meetings of the Institute at Chicago the next year together with the consequent publicity that the movement gained through the *Prairie Farmer* and other journals led eventually to the movement becoming a national one. Papers like the *New York Horticulturalist,* the *New York Tribune,* the *Philadelphia North American* and the *Southern Cultivator* took up the cause while Turner and his associates in the Industrial League of Illinois, an organization that had been founded to foster this matter, through writings in the newspapers, pamphlets and speeches throughout the country, won friends for his scheme of educational advantages for the masses through governmental aid. In 1854 Illinois Congressmen presented a resolution from the Illinois State Legislature regarding the establishment of Industrial Universities in both houses of Congress, but with little effect.

It was at this time that Representative Justin A. Morrill of Vermont became interested in the matter and consented to introduce a bill embodying the Turner scheme for governmental aid which provided for "a land-grant to each state and territory of 20,000 acres of public land for each Congressman and delegate."

These lands were to form a permanent endowment for these schools of agriculture and mechanics arts which the states were to establish within five years after the passage of the bill. This was the initiation of the Morrill Land Grant Act which from this time until its final passage in July, 1862, met with many vicissitudes. Once it failed by an unfavorable report at the hands of the Committee upon Public Lands; once it passed the House, awaited until the next session for Senate action, was passed eventually by the Senate only to be vetoed by President Buchanan. Abraham Lincoln as a candidate was in favor of the bill, as was Stephen A. Douglass; and Lincoln is said to have pledged himself to sign the bill if elected. He was elected and thus it was left for a second citizen of Illinois to sign and make law the bill that had

originated in the brain of Professor Turner. Consequently it will be seen that Illinois is inseparably linked with the "land-grant" movement and that in the fight for a state university of "agricultural and mechanical arts" in Illinois originated the law that gave rise to similar institutions throughout the Union.

The Morrill Act provided, instead of the 20,000 acres for each Congressman as proposed by Turner, 30,000 acres and this apportionment yielded the University some 480,000 acres. The wording of the Act appropriated this land "for the endowment, support and maintainance of at least one college, whose leading object shall be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanical arts."

The State promptly accepted the grant and proceeded to locate the University. The attempts to "land" the new institution precipitated a lively "scrap" between Springfield, Bloomington, Jacksonville, Urbana, and one or two lesser aspirants, all of which offered bonuses of one sort or another. Urbana offered the Urbana and Champaign Institute building then nearing completion, 1,000 acres of land and $100,000 in county bonds bearing 10 per cent. interest while the Illinois Central Railroad offered $50,000 in freight, the whole of which totaled some $450,000 according to estimates of the day. Urbana was chosen as the seat after a lively fight in the Legislature and the University was accordingly chartered February 28, 1867, under the name of Illinois Industrial University.

The first regent (president) was Dr. John Milton Gregory, then president of Kalamazoo College, Michigan, who came to his duties on April 1, and by hard work had the institution ready for the reception of students, March 1, 1868. Under the wording of the Act, the regent saw the opportunity for the establishment of a real "university" and began by laying a broad foundation for the great growth that, although it did

not come in his day, he was sure would follow. In this connection it is interesting to note his proposals to the Board of Trustees for the organization of the institution. He proposed:

I. The Agricultural Department, embracing:
   1. The Courses in Agriculture proper.
   2. The Courses in Horticulture and Landscape Gardening.

II. The Polytechnic Department, embracing:
   1. The Course in Mechanical Science and Art.
   2. The Course in Civil Engineering.
   3. The Course in Mining and Metallurgy.
   4. The Course in Architecture and Fine Arts.

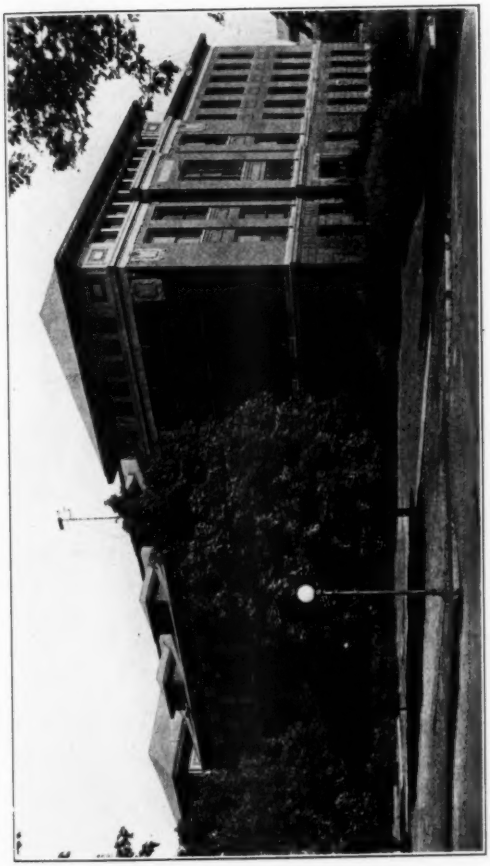
III. The Military Department, embracing:
   1. The Course in Military Engineering.
   2. The Course in Tactics.

IV. The Department of Chemistry and Natural Science.

V. The Department of Trade and Commerce.

VI. The Department of General Science and Literature, embracing:
   1. The Course in Mathematics.
   2. The Course in Natural History, etc.
   3. The Course in English Language and Literature.
   4. The Course in Modern Language and Literature.
   5. The Course in Ancient Language and Literature.
   6. The Course in History and Social Science.
   7. The Course in Philosophy, Intellectual and Moral.

The "University" was opened to men only at first, women not being admitted until 1870, and compulsory manual labor in shop or upon the farm was at first required of all. Compulsory labor was abolished, however, in 1869. In 1868 the first chemical laboratory was fitted up and in 1870 the first mechanical shop, the earliest in any American university to



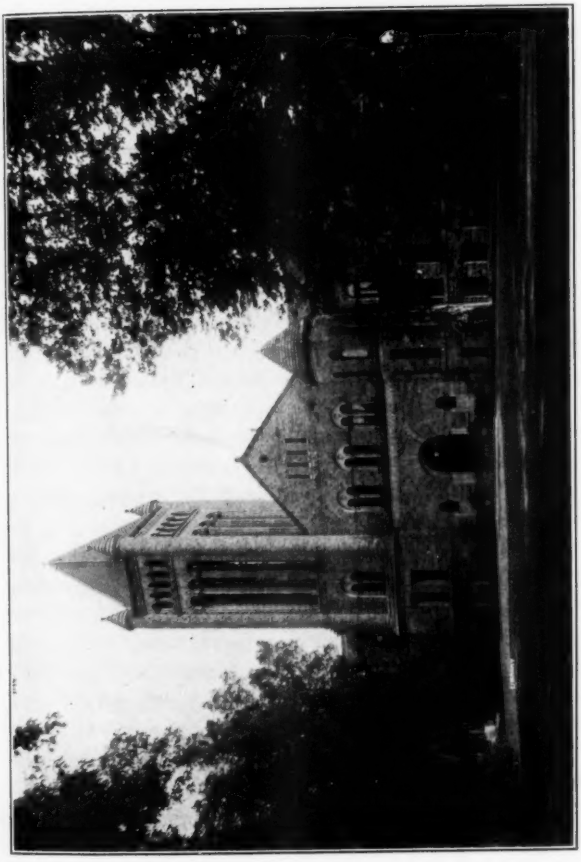
Laboratory of Physics—University of Illinois.

provide shop instruction, was opened. These features doubtless served to divert the energies of the lads, many of whom came from active lives upon the farm. In the beginning degrees were not granted, certificates of accomplishment being given instead, but this practice was so far from the current procedure of the day that in 1877 the law was changed making it possible for the University to grant the usual degrees.

Another early difficulty, that of the mistake in the choosing of a name, became apparent about 1880 when a number of states began to establish reform schools, orphan asylums and houses of correction under the general term of "industrial schools." Many of the graduates of Illinois found themselves possessed of degrees from an institution to which a stigma attached because the general public did not understand its purpose or the significance of its name. This the General Assembly sought to remedy in 1885 when the official name was changed to the "University of Illinois."

The growth of the University in point of enrolment was slow but steady from the date of foundation until 1897 when it passed the 1000 mark, with the exception of the decade of 1880–90 when there was practically no increase in numbers. In the five years immediately succeeding 1897 the student body doubled, and redoubled again within the next seven years. At the outbreak of the world war the enrolment stood at almost 7,000 to suffer in common with all colleges the repressions of the war period. In 1920–21 the enrolment was 9493, and in the present year is 9600. While this growth in student body has been taking place, the faculty has increased from four in 1868 to 806 in 1922, besides 305 clerks, assistants, librarians and others.

The University at the present time is comprised of the following administrative divisions, the germ of the most of which can be traced to the proposals of the first Regent: the Colleges of Liberal Arts and Sciences, Agriculture, Engineering, Commerce and Business Administration, Education, Law, Medicine, Dentistry, Pharmacy; the Schools of Music, Rail-



Library—University of Illinois.

way Engineering and Administration, the Graduate School and the Library School. In addition to these colleges and schools, the University conducts a Summer Session, an Agricultural Experiment Station, and an Engineering Experiment Station; operates the University Press; conducts Short Courses for Farmers and Stock Growers, Highway Engineers, Ceramic Engineers, Electrical Metermen, besides frequent convocations for the consideration of public, educational and municipal administrative problems. The following state service departments are located at the University: the State Natural History Survey, the State Water Survey, and the State Geological Survey.

The problem of providing material equipment and housing for so diversified a group of colleges, the rapidly growing staff and student body, has been and still is one of the serious problems at the University. The campus comprises some 238 acres in addition to an experimental farm of 991 acres, and at the present time there are fifty-three structures upon the campus. Like most American university campuses the varieties of architecture are numerous and the campus has been referred to as "an architectural museum." Few of the buildings are extremely old, however, and even University Hall (1873) still functions as the main academic "class-room" building. The constant demand for more class-room has operated often to put aesthetic considerations in the background and utilitarian ends in the foreground. The buildings are "educational plants" rather than college structures in the commonly accepted sense. This has not operated, however, to make them entirely devoid of charm or of beauty. The University Library (Ricker and White, Architects) is generally conceded to be one of the most distinguished examples of the Richardsonian Romanesque in the Middle West, while the older parts of the Women's Building (McKim, Mead and White) is a most excellent example of the American Georgian style. Several of our newer structures are in a style eminently appropriate to our broad prairie vistas, and real

contributions toward the solution of our architectural problems in the middle west have been made.

The campus of Illinois, in spite of its rather even topography and its lack of water, river or lake, has a wealth of fine trees, set out upon the prairie many years ago through the foresight and efforts of Doctor Burrill. It is a pleasant, natural place, the beauty of which will be enhanced as time goes on through the efforts of the Campus Planning Commission.

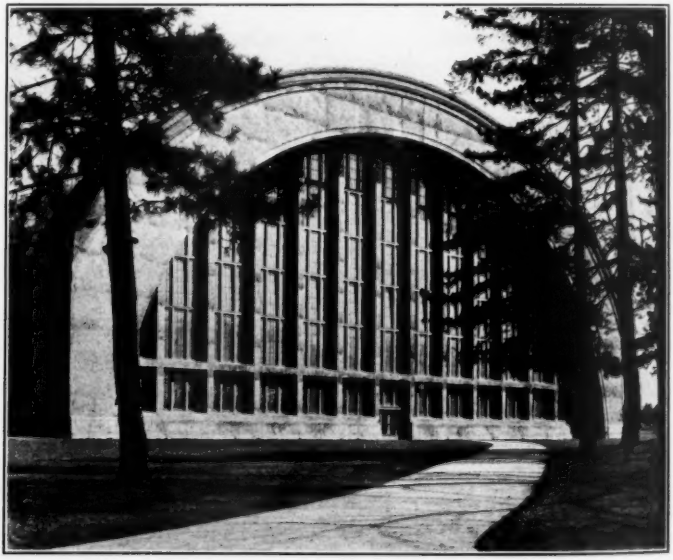
The library of 470,000 volumes has long since outgrown the present structure with the result that an interesting and not totally illogical system of departmental seminars has grown up. These are housed in the various buildings about the campus, the principal collections being in Lincoln Hall, Engineering Hall, Natural History Hall, and the Agricultural Building, to say nothing of smaller collections in law, physics, chemistry, etc., to be found in these respective buildings.

In the absence of a general university museum, the same is true of the museum collections, the principal of which are Natural History Museum in Natural History Hall and the Museums of Classics, Oriental and European Culture in Lincoln Hall. Other collections are housed in buildings in close proximity to the work to which they relate.

The College of Engineering in which most of our guests will be interested is housed in a unified group of fourteen buildings on the north side of Green Street and just across from the main campus. Thus the work in engineering is concentrated in a relatively small area with the result that the student's time is economized in traveling about the campus.

While the practical problems of teaching an ever-increasing group of young men and women and providing proper facilities have been preëminently the business of the University during the first half century of its existence, sight has not been lost of that very important phase of every state university's work, namely, research and the dissemination of the results of that research to the people of the state and

nation. In keeping with the high purposes of the first promoters of a university in Illinois, research has from almost the beginning been given attention. An enumeration of the results of productive scholarship at the University would yield an astounding list of distinct contributions to human knowledge and a totalling of the benefits of the same to the industrial and agricultural interests of the state and nation would run into the millions of dollars. Both the state and the University have laid great emphasis upon this very important work and its service to the state, and liberal appropriations are made for it. The coöperation of the Federal Government in the support of the Agricultural and Engineering Experiment Stations, together with liberal endowments from commercial agencies like the railroads, manufacturers and manufacturers'



New Armory—University of Illinois.

associations for the investigation of certain problems, have made possible extended investigations that would otherwise have been impossible.

The distinguished work of such men as Hopkins, Davenport and Graham in agricultural science; of Noyes and Parr in chemistry; of Burrill and Forbes in natural science; of Greene in history; of Garner in political science; of Stebbins in astronomy; of Talbot, Willard and Moore in engineering, are well known everywhere. And in the future research and constructive scholarship must play an ever-increasing rôle among the activities of a great public servant, as in a state university.

In the next half century agriculture in the Central West will become increasingly diversified; the problems of farm-waste utilization, scientific warehousing and marketing, rural economics and sociology and many other rural problems must receive attention. The Agricultural Experiment Station is the agency best fitted to solve many of these problems. At the same time, if present-day tendencies portray the future, Illinois will become more and more a great industrial and manufacturing state. The problems of the mine, the investigation of engineering materials, the scientific investigation of manufacturing methods and the handling of materials together with the problems of transportation, road-building, heating and ventilation, sanitation and public health, will all call for attention from engineering specialists, and operate to make the Engineering Experiment Station increasingly valuable to the people. The University of Illinois has made a distinguished record for herself along these lines in the past. She will do even more in the future.

THE NEED FOR MEASUREMENT IN ENGINEERING EDUCATION.*

BY J. CROSBY CHAPMAN,

Associate Professor of Educational Psychology, Yale University.

The two questions which are of the greatest concern to the individual instructor, namely, the amount of material to be covered and the method of presentation, cannot be effectively attacked until extensive measurements have been made of the attainment of students under present conditions of instruction. Let us confine our attention to that question which pertains to the amount of material to be presented. While the nature of the subject matter of any specific course is determined by considerations external to the classroom, the quantity of subject matter presented within any specific course or period lies wholly within the hands of the educator. What shall be the criterion for judging this quantity? Many will feel tempted to reply that the quantity of material is determined by the knowledge and skill required of the trained student. While this is true of the whole course of study, it does not give an answer to the specific question as to what shall be the criterion of quantity for a given period of time. It may well be that the total course of the student, in view of the increased demands of the profession, should be extended by a year, but this does not affect the main problem of the individual instructor as to the exact amount of ground that he should cover within a single course.

The answer to this problem is not found in any course of study; it cannot be determined by a consensus of opinion extracted from analyses of catalogues of various institutions; it can only be settled by a careful study of the attainments of

* Presented at meeting of Yale Branch, Society for Promotion of Engineering Education, Dec. 1921.

the students under instruction. The end of the teaching process is found in the changes which it has made in the student. The engineer is not produced by any mystical process of general instruction, he becomes an engineer because from day to day by meeting this situation and that situation, certain changes are made which show themselves in this particular skill and in that particular element of knowledge. There is no virtue in being exposed to the process, there is no saving grace in covering the ground, the final question remains—to what extent have the necessary changes been made and to what extent will they abide?

As long as we make no determined and scientific measurement of our success or failure to make these changes, we can hardly expect to get much light on the alterations that we should make in the process of instruction. As long as we only know in a very hazy way the extent to which we are succeeding in the classroom, we can have no definite evidence to present in the attempt to change present practice. It is to controlled experiments measuring the degree to which the students have derived the information and acquired the skills desired, that we may look for improvement in the teaching. Let me illustrate by a specific case. In a big city school system the question arose as to content and method of teaching of high-school physics. To attack the question the author urged the teachers to make a beginning in the direction just outlined, and determine the degree to which the pupils were mastering the material that was then being taught. To accomplish this, every teacher supplied a number of straightforward questions covering the minimum essentials of the subject. On the basis of frequency and in the interests of covering the whole field, out of two hundred questions submitted thirty were finally selected. These were recast into a simple one-word-answer form. These questions, concerning the answers to which there was no possibility of subjective judgment, were given under uniform conditions, without time limit, at the close of the physics course, to all the physics classes.

The results were most interesting. In spite of the statement of many of the teachers that the questions were much too easy, and that it was waste of time to give them, the results clearly showed that the teachers, with one or two exceptions, had lamentably failed to estimate the degree of knowledge acquired by their pupils. There seemed to be an almost touching belief in the power of the pupil to grasp and retain material that had been "gone over," and revised in class. In place of the almost perfect scores confidently predicted by many of the teachers, the median pupil did not score more than half the points, and the range of score of the individual pupil was from five to twenty-eight. It was not until definite objective results of this order were obtained, showing in an indisputable manner the discrepancy between the ambition of the curriculum and the attainment of the pupil, that it was possible to get favorable action upon the reduction of the course of study.

It is such experiments as these that must be conducted in every professional school. It is not a matter of how much we should like to teach, it is not a matter of how much ground can be covered by the instructor, the determining factor of the whole process is the capability of the pupil to grasp and retain the instruction. The students should, for certain purposes, be looked upon as mechanisms of varying degrees of strength which can be subjected to certain stresses and strains. If these stresses and strains do not exceed a certain critical point, and are applied at suitable intervals for a sufficient period of time, the mechanisms will respond; if, however, these conditions are not fulfilled the desired changes will not result. Let me illustrate again: bearing in mind the limitations of intellect, training, memory, etc., is it feasible to expect the student to grasp the second law of thermodynamics in the time that is usually given to it in the course? Is it within the limits of the human mechanisms which condition the process? What right have we to expect adequate performance when we are subjecting the machine to an impossible load? Again,

to learn to use calculus with a defined facility, to see and sense the problems to which it can be supplied, requires time, a definite time, t, for each individual x. Is the ordinary engineering student allowed or made to spend this time?

As an educator I am not worried that the student will be over-stimulated, and break down; there are too many efficient safety valves. The danger is rather that the instructor realizing the impossible situation will compromise with standards to such an extent that the course of study, instead of standing for a definite achievement on the part of the students, will represent rather the pious hope of certain detached individuals who have forgotten what are the limitations of the undergraduate, and one might almost say, the human mind.

Methods have already been evolved, and are now being used in other fields, for determining with a certain degree of precision the benefits derived from instruction, by the student body. As a result of such measurements, two tendencies are apparent. The first tendency reveals itself in an open-mindedness and a desire to experiment with various methods of instruction, such as the lecture system, notetaking, problem method, constant revision, etc. The other tendency is shown in the reduction of the curriculum. Granted that in a particular course, covering three hours throughout the year, the students are failing to cover the ground and maintain a satisfactory standard of achievement, the quantitative problem as to how much elimination must take place in order to obtain reasonable efficiency is being investigated.

The problems of the classroom will, like most other human problems, yield to scientific treatment. Scales for measuring achievement in the various branches of engineering must be patiently and painstakingly constructed. Similar scales in more difficult fields than those presented by engineering are already in existence. This process is of course laborious, and its results are delayed, but the inductive solution of complex problems cannot be hurried. Unless engineers are prepared, both individually and coöperatively, to construct such scales

their teaching practice will be controlled by a hit-and-miss method which they would despise in handling the problems of their own laboratories. Engineers who take such care in the realms of physical measurement, can hardly be content to let their measurements of student achievements be so casual and scientifically worthless.

Having evolved the instruments for measuring achievement in the various branches of engineering education, the relative values of procedures and questions pertaining to the quantity of material presented will admit of quantitative measurement. "Ex cathedra" judgments in the realms of education are no longer acceptable. Progress will come by the faithful application of the scientific method. There is no professional group which should show more favor to this method than engineers, for, after all, the problems of education are merely intricate problems of human engineering.

DISCUSSION: FROM THE NOTEBOOK OF AN ENGINEER—II.

BY ERNEST G. BECK,

Wh. Ex., 70, Wellwood Road, Goodmayes Essex, England.

Moment of Inertia.

In a recent issue (Vol. XI, No. 8, 1921) of your Bulletin, there is an article entitled "From the Notebook of an Engineer—II. A Symposium on the Moment of Inertia," by Mr. R. Fleming; and in that article Mr. Fleming refers to my interpretation of the Moment of Inertia as a distance—the arm of a couple—and therefore measurable in inches, given in my book on "Structural Steelwork" (Longmans, Green & Co.).

Among practical men there is a widespread and keen desire that an interpretation be found for the Moment of Inertia in terms of physical reality—or, at least, of something physically realizable—in place of the present method of regarding it as a mere mathematical conception in four dimensions. This desire I have sought to meet in my book; and I should therefore be grateful if you would spare room in your Bulletin for this reply to the objection raised by Mr. Fleming against my interpretation.

I submit that the "definitions" for Moment of Inertia quoted by Mr. Fleming from a number of authorities:

" . . . product of an area with the square of its distance. . . . " (Rankine)

" . . . torque to produce unit angular acceleration. . . . " (Cathcart)

" . . . $\Sigma da.z^2$. . . . " (Merriman)

" . . . Second moment of an area. . . . "

" . . . a numerical quantity only. . . . " (Fuller & Johnston)

" . . . a group of mathematical factors. . . . " (Kingsbury)

have failed to find acceptance among practical engineers generally.

The reasoning from which my interpretation is deduced is set out fully in my book; and therefore it is not necessary to comment upon it here, except to state that the argument is readily capable of demonstration physically, step by step, by any ordinary student, with home-made apparatus of the simplest kind.

There is, however, one point which I desire should be clearly understood—*i.e.*, the mathematical expressions upon which my interpretation is based are precisely those used by the authorities quoted by Mr. Fleming, without so much as a single new term or factor. All that I have done is to *interpret* those expressions physically; and to state the inferences in words. After all, mathematics is but a form of accountancy; and a ledger entry is not worth much if it will not permit the substantial "reconstruction" of the transaction which it is supposed to record.

Even had Mr. Fleming shown (and he has not yet done so) that my interpretation failed to meet the facts, it would surely have been more politic to point out a fallacy in the basis or an error in the reasoning than to merely discredit the inference on no stronger grounds than the fact that he has allowed what is really an error in calculation to pose as an "unanswerable argument" against that inference.

Taking the case of the 6 x 12-in. timber chosen by Mr. Fleming in support of his "unanswerable argument," it is quite true that the leverage known as the Moment of Inertia is 864 inches; and equally true that it is also 72 feet. This becomes obvious if we suppose the timber to be such as will permit (*e.g.*) $f_1 = 1000$ lb. per sq. in., giving the Resistance

Moment $R = (1000\text{ lb.}/6)$ at 864 in. $= 144{,}000$ in.-lb.; or, alternatively, $R = (1000\text{ lb.}/6)$ at 72 ft. $= 12{,}000$ ft.-lb.

It should be observed that we do not change the *forces* of a constant couple by simply measuring its *arm* in feet where previously the same arm has been measured in inches.

Mr. Fleming cannot justify his inference that the Moment of Inertia for this case is $0.04\dot{1}6\dot{6}$ by application to the Resistance Moment (which, after all, is the fundamental basis of the matter) *unless he alters the forces of the couple also.* He must take his permissible stress in pounds per square *foot* of section area (thus increasing the forces in the ratio $12^2 : 1$); and he must still further increase the forces in the ratio $12 : 1$ because he has tacitly pledged himself to measure d_1, also in *feet.* This corresponds to a total increase of the forces in the ratio $12^3 : 1$; and if the obviously more convenient, authentic and rational course be adopted of keeping the forces unchanged, Mr. Fleming must increase his evaluation of the Moment of Inertia in the ratio $12^3 : 1$; giving

$$I = 0.04\dot{1}6\dot{6} \times 12 \times 12 \times 12 = 72 \text{ feet.}$$

It would appear that too often a highly important point is lost sight of—*i.e.,* the Resistance Moment (plainly a couple) of a beam depends upon two factors:

(1) the *forces* of the couple, which depend solely upon the material, and bear no relation whatever to the shape and size of the section; and

(2) the *arm* of the couple, which depends solely upon the shape and size of the section, and remains the same so long as the section is unchanged, whether the beam be made of wood, steel or stale bread—provided only that Hooke's Law be applicable.

What appears to me one of the strongest points of my interpretation is the clear emphasis which it lays upon this combination of characteristics, while keeping each free from interference by, or confusion with, the other. Mr. Fleming's

effort to equate 864 "(inches^4)" with 0.04166 "(feet^4)" necessitates a hopeless and most undesirable jumbling of what are, and clearly must be, two distinct and separate influences, which operate simultaneously in an actual beam, but are otherwise unrelated.

Another strong point of my interpretation lies in the fact that it reconciles the use of the term Moment of Inertia in Dynamics and Statics. My physical interpretations are equally applicable to the mathematical relations for a fly-wheel as to those for a beam; and the logical inference which follows is perfectly simple, satisfactory and consistent.

I have been favored by Mr. Philip J. Markmann with a copy of his pamphlet "Haze and Moonshine in Statics" (referred to by Mr. Fleming), in which the Moment of Inertia is interpreted as a length. The methods employed by Mr. Markmann are essentially different from mine, in that he does not show (as I do) the physical counterparts of the mathematical expressions step by step. Moreover, there is in Mr. Markmann's treatment a point which I submit is logically unsound; and which therefore weakens his argument. He instances a 20-in., 65-lb. beam, and quotes from the handbook for this section: $I = 1169.5$; and Section Modulus 117. Mr. Markmann then proceeds to speak of the "internal stress couple (104,000 lb. at leverage 18 in. approx.)" as the REAL couple; and of the couple "f_1 at Section Modulus" as an ideal couple.

Now, the former of these is no more *real* than the latter; nor is the latter any more *ideal* than the former. All that we may properly regard as *real* is the assemblage of component stress couples. If we then assume a single resultant force (equal to the sum of all the component stresses) on each side of the neutral layer, we obtain a single couple equivalent to the sum of all the component stress couples. This is, of course, a *hypothetical* couple; and not *real*. If, on the other hand, we take (as is distinctly implied by the accepted mathematical expressions) f_1 as the force, and adjust the leverages of the component stress couples, afterwards sum-

ming these adjusted leverages, we obtain another single couple equivalent to the sum of all the component stress couples. This, again, is a *hypothetical* (not an *ideal*) couple—and its arm we know as the Section Modulus.

If Mr. Fleming (and, of course, others) would care to discuss the matter further, with a view to effectually disposing of the points at issue, and thus establishing Moment of Inertia, Section Modulus and Radius of Gyration (both as regards Dynamics and Statics) upon a basis at once scientifically sound, logically supportable in simple language, readily demonstrable in terms of physical fact, and acceptable to practical engineers generally, I shall be glad to take part in such discussion should you be prepared to afford the necessary space.

PRACTICAL ENGINEERING COURSE AS GIVEN TO FRESHMEN BY THE CIVIL ENGINEERING DEPARTMENT AT THE UNIVERSITY OF NEBRASKA.

BY WM. H. PAHL,

Instructor in Civil Engineering, University of Nebraska.

Among some of the most familiar complaints that are heard from professional engineers and contractors concerning the capabilities of engineering graduates are the following:

1. That the graduate is not sufficiently instructed in his particular lines. This is probably the most common complaint.
2. That the graduate cannot handle men.
3. That the vocabulary of the graduate shows his textbook knowledge and a deficiency in the workmen's terms.
4. That the graduate is not familiar with tools and machinery and their various uses.

The criticism, although given in a friendly spirit, is not constructive and if asked to suggest measures to overcome these difficulties the engineer or contractor is "too busy to take the time." There is no need to go further as you are probably familiar with this phase of engineering education.

The view of the college is likewise familiar to you. To institute such a program that would cover the most important objections, namely, more detailed study of various subjects, would require at least two more years to be added to the present curriculum. Such measures would no doubt bar many of the future students.

The writer does not believe that the general opinion of college men, namely "swell-headedness," applies to the engineering graduate. Too many of these men have worked on

projects and rubbed elbows with the laboring class either before coming to college or during their collegiate career. True, they have an idea that they know something more than the ordinary man. Why shouldn't they? For four years they have read, studied and absorbed, and shown themselves capable of passing a required standard. Any graduate not possessing this feeling must be lacking in self confidence.

Keeping in mind then, what the professional engineering world expects from the graduate, with the limitations of a college course, and with the idea that the student should learn more of working men and their ways, the University of Nebraska instituted a course in "Engineering Construction" for its freshmen civil engineers. Remember that the engineering college is not trying to remedy all ills but to help to eliminate some of them. Before this course the C.E. freshmen were required to take shop work in mechanical engineering. Having the "Engineering Construction" inserted, allows the student an option that is important should he decide to change to M.E. from C.E. after his first year.

From the first semester registration a total of fifty-nine students was had among which were three architectural, and one electrical engineering freshman. Of forty-seven civil freshmen, forty were registered. The remaining fifteen were upper classmen, who needed credit in freshman work.

The second semester registration shows a total of twenty-three civil engineering freshmen, out of a possible thirty-four. The total class is thirty-four.

Unfortunately, however, the members of the faculty who were responsible for this change resigned, leaving the details to be worked out and the original idea to be changed to meet the requirements, or the obstacles raised in the mind, of the new faculty. The program of the original course as outlined to the writer was, namely, that the upper and lower classes were to coöperate. For example,—suppose the university required a new drain. The seniors and juniors would collect sufficient data to do the designing and draft-

ing. The sophomore class would be responsible for all surveying in connection with the work. Then the freshmen would do the actual construction, some of them acting as foremen, timekeepers, etc. All the classes were to be under the guidance of the instructors of the various branches. No doubt this arrangement has its advantages but when all is said and done it is merely an experiment conducted in an enlarged laboratory.

After giving the subject some thought, it was decided that the best thing to do would be to place the students on construction work being actually performed by the various contractors in Lincoln. The freshmen would then be under real foremen, and receive compensation for their efforts. This plan would place the students among the laboring man, giving them his viewpoint; teaching them the amount of work that can be expected of a man, and knowing what the workman expects and how he labors, would probably prevent the graduate from becoming a "slave driver." Another highly important feature of this plan would be the development of the power of observation.

Accordingly most of the contractors and engineers in Lincoln were visited and the following proposition placed before them in this manner:

"The C.E. Department of the university has so many freshmen who are taking a course entitled, 'Engineering Construction.' The object of the course is to teach them the practical side, learn to handle men, observe how different contractors do things, etc. We are asking your coöperation. Of course we expect that you will pay them a little less than your common labor. Not because they are worth less, but to allow these students ten or fifteen minutes from work so that they may see what is going on. They will be under your foreman at all times. The men are not to be handled with kid gloves and we would appreciate the reporting of any man that soldiers on the job.

"No doubt you have employed college men before who were lacking on the practical side. Working under a contractor is about the best way of acquiring this information.

With your coöperation we can turn out better men who will come to you after graduation and earn what they are getting and more."

The cordial reception by every one of them and their willingness to help goes a long way to prove that graduates who come to them have not been sufficiently informed on the practical end. One great drawback was the impossibility of disrupting a contractor's organization which would be required, to place the students for a two-hour period. This was the only reason several contractors refused to take the men, and not because they failed to endorse the plan.

At the first meeting of the class the students were told the details, what was expected of them, what the contractors were doing to help. They were also cautioned to carry a notebook to jot down notes or anything they might care to record. Anything not perfectly clear was in this way brought to class and discussed. The C.E. Department has a three-ton truck. This was supplied with benches and then used to carry the classes to and from jobs and inspection trips.

The various kinds of work upon which the students were employed were:

12-inch tile sewer—digging ditch.
Segmental block sewer—digging ditch.
Steel fabricating shop.
Building, mixing and pouring concrete.

The details in executing the plan can best be explained by using the first job as an example.

On this 12-inch sewer they dug ditch. There were no questions asked on the work, the idea being to let them develop their own powers of observation. While they were digging, the pipe-laying gang was close by. Two students at a time would quit digging and go back to watch the pipe gang and pick up any other information. While watching they had the opportunity to ask questions. If they had no questions they were then questioned. This would usually call forth other points.

It only took this one job to give them the idea. One man could not see what was to be observed or what information gathered. After questions such as—Are you digging up or down hill and why? How is the tile inspected? How do they get line and grade? What information must be had to design the sewer? and so on, he immediately changed his mind.

Getting them to observe was a difficult task. For example, in the material yard at the steel shop stood a sixty-foot steel mast and boom guy derrick. Yet some of the students had been there three weeks and did not remember seeing it. The best correction was to call them to speak in front of the class, telling what they had been doing, observing and learning. As they received their grades upon these recitals it brought about the desired effect.

While such things as refusal to work and slacking were to be expected, the number of cases were few. Only one student was reported for "soldiering." Several men also refused to take the course and thereby ended their collegiate career at an early date. In both cases, measures were immediately taken that ended any such attitude on the part of the students.

On account of the let down in building during the past fall, the men had to be recalled. Naturally this acted as a severe check on the course. Recourse was had to inspection trips and to lectures.

The lecturers were men who were well known in their respective lines. It was found that the students gave more attention to them. Engineers, contractors, heads of labor unions and men engaged in welfare work gave their services freely. No attempt was made in securing these men to create a certain opinion among the students. The reverse was true. The various subjects covered by the lectures gave the student the viewpoint from the engineer's, contractor's, labor union's and welfare worker's angle. This feature of the course was well received by the freshmen.

1. Inspection trips were also chosen with the idea of seeing various kinds of engineering and construction. The trips taken were:

2. Lincoln Brick Works where hollow tile was being manufactured.

3. Cushman Motor Works—assembling of motors from the foundry work to the completed motor ready for shipment.

4. Placing of concrete sidewalks.

5. Buick building from foundation to roof. This building of flat slab-mushroom column construction.

6. C. B. & Q. Concrete Plant. This included deck slab, fence posts, and concrete piles both driven and jet.

7. C. B. & Q. Repair Shops.

8. Salt Creek Sewer—watching them dig trench and lay segmental arch.

9. University Place Sewer—watching trenching machine and back-filling machine operate.

10. Gooch's Flour Mill.

11. A Street Pumping Station—boilers, engines, condensers, turbines, etc.

12. St. Elizabeth's Hospital addition. This construction is of reinforced concrete beam and girder. Four trips were made to this job to watch the operation and see how things were being done. On all these trips opportunity to show the students such things as steam shovels, concrete mixers, bond in brick work, the various parts of windows, kinds of roofing, etc., was taken.

All the places visited were only too glad to detail a man to show the students around and every courtesy was shown. The next period the class met following the inspection trip an oral quiz was held to see what had been learned and to further point out certain parts of the building or work.

The second semester has been devoted to class work, using a text by Hatt and Voss entitled "Concrete Work." This book uses a small reinforced concrete tool shop as an example, starting with an abbreviated chapter on cement and

concrete and then going through the entire construction from the plans and specifications to the appendices on cement testing and data for estimating. Each phase of the construction such as excavation, footings, forms, etc., receives adequate explanation. Theory is not expounded, only the practical side. This book just fills the gap caused in last semester's work, namely they are studying about what they have already seen. Problems are assigned from the text and written quizzes occur at frequent intervals. To date the results have proven quite satisfactory. Whenever possible to see some new construction the classroom work is abandoned.

This completes a description of the course and its method of execution. There are several things however that can be noted and should be inserted if possible to make the course more successful.

1. The laboratory period should if possible be arranged as a six-hour one. This will do much toward securing outside employment as it will not disorganize the contractor's gang. When there are two periods the outside working time is at a maximum two hours.

2. The classes should be kept about the same size. Large classes are awkward to handle.

3. The instructor must have proper support from his superior to eliminate slacking and refusals to work.

4. Frequent written quizzes should be held to assure the student that the taking of notes is necessary.

5. Lectures should be given by prominent contractors and engineers.

Such a course has many advantages not only in gaining a practical knowledge but on the preparations for upper class work. With a normal building era the course can be made very interesting and attractive not only in civil, but in any branch of engineering.

THE CALIFORNIA INSTITUTE OF TECHNOLOGY. ITS AIMS AND PURPOSES.*

BY DR. ARTHUR A. NOYES,

Director of the Gates Laboratory of Chemistry.

Dr. Millikan scarcely needs an introduction. In the short time he has been here, he has become well known. But as this is the first formal occasion, it seems appropriate to say on behalf of those of the staff previously here a few words of welcome and congratulations.

"Dr. Millikan was invited here in pursuance of a definite policy of the trustees of the institute. This policy is, not to spread the work at once over all fields of science and engineering, but to build up one by one the strongest possible departments beginning with those relating to the basic sciences and to place in charge of each of them the very best man in the country who can be found.

"When through the liberality of Dr. Bridge it became possible to provide a fine new building for physics which should include ample provision for research, the opportunity came for developing in a large way physics (and with it mathematics) which are the sciences most fundamental to all branches of engineering. And the problem was to secure the best man in this country to take charge of it. One part of this problem—often a difficult one in such cases—was easy: the decision as to who that man was.

"There wasn't the slightest doubt that Millikan was the man. We all well knew his personal qualities from our association in Washington and his previous visits to Pasadena, and there was no question as to his outstanding position in research and scientific education.

"The problem was how to draw him away from Chicago. He had built up there the largest and most successful physical research laboratory in the country. He had a group of twenty

* Pasadena *Star News*, January 30, 1922. Dedication of Norman Bridge Physical Laboratory and the Installation of Dr. R. A. Millikan as Director.

or more graduate students working with him. He had the long-established cordial association of twenty-five years—the loyalty and devotion to the university which such associations produce. But fortunately he is so young that he could still break away from old associations and he had the vision to see that the position here offered the opportunity to do something quite unique in education and to build up a new research laboratory which would not replace but supplement that which he had already created. If he had regarded this institute as merely one more of the same type added to the scores of colleges already existing, he would never have come. He saw, however, the unique possibilities which lay in the policies definitely adopted by the trustees—the policies, namely:

"(1) That the institute should limit the number of its undergraduate students to a carefully selected group and restrict the number of its departments so that there will be ample funds, laboratory space, and equipment to give the highest type of instruction and leave opportunity for full development of graduate study and research.

"(2) That strong emphasis be placed in the undergraduate courses in the fundamental sciences (physics, chemistry, mathematics) and on humanistic studies so that the graduates may become the broadest type, not the technical type, of engineers.

"(3) That such conditions of student life be created that the broad human qualities may be fully developed.

"(4) That research be extensively introduced in all the science and engineering departments of the institute because of its own importance to human development and because of the vitality it imparts to all the instruction.

" Dr. Millikan had the imagination to see what an institution developed along these lines meant as a contribution to American education. And he relinquished one of the best university positions in America and came to us, and here he is."

REPORT OF BRANCHES.

The University of Arkansas.

The University branch of the Society for the Promotion of Engineering Education, which is supposed to be located at Fayetteville, consists of four members only. We have met a few times informally to discuss methods of teaching.

As Fayetteville is a small town, isolated from any larger engineering centers, it is impossible for us to enlist in our Branch more members at the present time. Therefore, our discussions have been largely of interest only to the few men who have met together. We have not done sufficient work to make it worth while to make a formal report to the Society.

W. N. Gladson.

University of Florida.

Your letter of January 16, asking for a brief summary of the important points discussed and the conclusions arrived at, during our meetings here, came to my attention too late to get a letter to you by January 23. We had but one meeting and there would have been little or nothing to write about. The only engineering school in Florida is the one here at the University and we have not as many to draw on for membership as in other sections of the country.

The University of Florida is a new institution and is developing rapidly, and ranks now with any of the institutions in the South. The engineering college has to turn away young men each year because we can not take care of them. The faculty is very busy with the college work, but we try to help out in the faculty clubs and student societies already active. Many of the points brought out in the published reports of the S. P. E. E. are discussed in these society meetings. I do not think any of us are making complaints con-

cerning the S. P. E. E. or what it is doing. We are not really doing much for the S. P. E. E., but hope to keep in touch with the society until such time as we may be able to give it more active support. Possibly I have written a lot and not told you anything, but if you were in a similar position, you would understand.

P. L. REED.

UNIVERSITY OF MICHIGAN.

Following the suggestion of President Scott, J. Raleigh Nelson, Institutional Delegate from Michigan at the last annual meeting, called the local members of the S. P. E. E. together for an informal dinner and conference at the Michigan Union, Thursday evening, October 27. About forty members of the engineering faculty were present, including the officers of administration and the heads of most of the departments. The social hour preceding the dinner gave many of the men in the English, modern language and mathematics departments an opportunity to meet men in the technical department whom they seldom meet in any way except at the formal faculty meetings. Many have expressed the feeling that if the meeting did nothing more than get us better acquainted, it had been well worth while. Following the dinner, the following topic was proposed for discussion by the chairman:

"How Can Our Engineering Teaching Be Made More Humanistic in Its Effect?"

The subject is closely related to a number of other questions, among which the following were suggested: what do we mean by the humanities; how important is their effect in the education of a professional man; what subjects in the engineering curriculum have humanistic values; can scientific and technical subjects be so taught as to produce the same effect; should the cultural influence of such humanistic studies and of humanistic teaching be confined to one part of the student's course or should it be continuous and constant throughout the length of his college residence?

The discussion led very directly and very helpfully straight to an attempt to define what we mean today by the humanities. It was recognized at once that the old limited definition had been superseded by a broader interpretation of the term. Any subject taught in such a way as to appeal to the interest, imagination, enthusiasm and to develop taste, discriminating judgment, sympathy, personality, to broaden and enlarge the background and widen the horizon of the student was generally admitted to have humanistic values.

At the time of the Renaissance when the term "humanities" was first applied to subjects having human and social interest, as opposed to the theological studies, the interest in the great civilizations of antiquity opened by the key of the ancient languages served to correct the overemphasis on theological speculation. So now the emphasis on human and social values might reasonably help to balance the tendency toward overevaluation of material and practical values. In so far as the very spirited and interesting discussion led to any definite conclusion, there was an agreement that inherent in most of the studies in the engineering curriculum there are humanistic values, but that they can be made effective only through enthusiastic, inspiring teachers.

So profitable did the entire occasion prove that it was unanimously voted to arrange for a series of such meetings for the discussion of educational problems to which all members of the engineering faculty should be invited, whether members of the S. P. E. E. or not. The sentiment favorable to the organization of a Local Branch was not sufficiently strong to make it advisable to propose any very formal arrangement, but a Chairman was appointed who was directed to arrange for further meetings. The hope was expressed that the interest shown in this first venture might spread to all members of the faculty and that our regular faculty meetings might thereby be given a new impulse away from the discussion of administrative detail toward the discussion of educational policy. If this fruit should ultimately result from the seed

sown in these meetings of our local S. P. E. E. members, a great service would indeed have been rendered the cause of engineering education.

The University of Oklahoma.

A technical group at the University of Oklahoma consists of those teachers who devote all of their time to the teaching of engineering subjects. This group meets twice a month for the purpose of discussing subjects pertaining to engineering education. Committees are appointed to study a subject they deem fit for discussion. This subject is then presented at our regular meeting and a discussion is carried on by all members present.

Coöperative Bookstore.

The first subject taken up this year in the technical group meetings was that of a coöperative bookstore to be managed by the students and furnish books and supplies to the students. It had been reported that various prices had been charged for standard texts and supplies. Some students were already dealing in books and supplies and a move was already on foot to establish a coöperative shop.

In our discussion it developed that the general opinion was that the merchants who had capital invested and were performing satisfactory service should be protected against a group of students or transient student organizations which tend to undermine the business or establishment. The opinion was expressed that it was preferable to order books and supplies through a reliable, well-established firm rather than a student organization.

Since then a coöperative store seems liable to develop. The Board of Regents consequently established a book exchange for the purpose of supplying books and supplies at approximate cost to the students. This book exchange is to be under University control.

General Course.

There has been considerable discussion from time to time regarding professional subjects in the second semester of the first year of engineering work. The students were required to choose a professional subject at the beginning of the second semester and it was the consensus of opinion that a good majority of the students had no idea as to what particular course they really should take. The discussion pointed out that before the war we were going toward a general course, but that the war and S. A. T. C. caused specialization to be placed earlier until we finally arrived at the professional subject in the freshman year. This seems to be unsatisfactory and the trend now is to get away from it. The discussion brought out the fact that the only difficulty seemed to be from an administrative standpoint. Schedules and hours would necessarily require some adjustment. It would probably be impossible to make the change immediately, as the change would result in confusion of courses and schedules. It was, however, agreed upon that eventually the student should not be required to choose the specific course he wishes to take until the fourth year and then to specialize in that course. For the first three years general subjects from all the principal branches of engineering should be included in the general engineering course.

The result of the discussion on the general course led to the discussion of a general freshman course as a stepping stone to the other. A move is on foot at this time to arrange the course so that the first year's work for the coming school year will be the same, no matter what the student decides to take.

PURDUE UNIVERSITY.

Referring further to your suggestion in letter of January 9th regarding the above subject, I am sure you will be pleased to learn that a very interesting and enthusiastic meeting of local members of the S. P. E. E. and colleagues in Engineering

and allied faculties of Purdue University, was held in connection with an informal dinner on Thursday, February 6th.

The subject under discussion was that of sectioning students in accordance with their ability to progress in the various courses, rather than by the arbitrary or alphabetical method used at present.

At the suggestion of Dean A. A. Potter, who was responsible for the success of the meeting, assisted by Professor J. D. Hoffman, chairman of the Membership Committee of the S. P. E. E., a very successful program, bringing forth the various experiences of the heads and instructors of the different departments was carried out. This method of sectioning students is being tried out as an experiment in several of the courses, and although the plan has not been under way for any great length of time, some interesting results have been noted already by the instructors in charge. Opinions seem to be pretty well crystalized to the effect that such methods are very much more satisfactory for the better men in the class, in order that they may advance more in proportion to their ability, but the effect on the sections consisting of less able men is considered to be open to question.

If it is possible to grant additional credits to those in the advanced sections and possibly discount credits from the course carried by the poorer sections, it is believed by many that the plan would be successful.

With regard to the meeting of the Branch, I think it is generally felt that the opportunity thus provided for informal discussion of points of teaching problems of mental interest is well worth while, and we hope to have a number of similar meetings in the future, concentrating upon certain subjects of particular interest to those engaged in teaching engineering students.

C. Francis Harding.

A. & M. College of Texas.

Referring to your letter of November 30, to Professor F. C. Bolton of this College, relative to the possibility of converting the Engineering Teachers' Conferences of the Agricultural and Mechanical College of Texas, into a branch of the S. P. E. E., I wish to state that Professor Bolton brought this matter up at the January meeting of our Conference after explaining that in your opinion it is not necessary that every one who is a member of our Conference by reason of his connection with this college become a member of the parent Society in order to enjoy the privileges of the meetings as a section of the S. P. E. E. A committee was appointed to consider and report at our February meeting and this committee brought in the following recommendations:

"1. We recommend that the Dean of Engineering be authorized to apply for authority to form the Agricultural and Mechanical College of Texas Branch of the Society for the Promotion of Engineering Education and that membership in this branch remain the same as for the Engineering Conference, namely, all Instructors in the College who teach students in the School of Engineering.

"2. We recommend that in making application for authority to form the Branch the application state that it was made with the understanding that qualifications for membership in the Branch are to be outlined as above."

In line with the recommendations of the committee I, therefore, as Dean of Engineering in the A. & M. College of Texas, desire to make application for authority to form the "Agricultural and Mechanical College of Texas Branch of the Society for the Promotion of Engineering Education" and if any special form must be followed in making this application I will appreciate it if the Secretary, Dean F. L. Bishop, of Pittsburgh, to whom I am sending a copy of this, will send me the necessary blanks or instructions.

I should state that our Engineering Conference has been holding regular monthly meetings during the scholastic year

for several years. We discuss problems relating to our instruction in particular, in the main, and all members of the instructional staff of the college who have classes composed of engineering students are expected to attend these meetings. Only a comparatively few of those who attend are members of the S. P. E. E., and many are not identified closely enough with the purposes of the S. P. E. E. to cause them to apply for membership in the Society. The formation of a section here should have the effect, however, of adding a number to the parent organization who are not now affiliated with it. No fees have been required for membership in the Engineering Teachers' Conference.

J. C. NAGLE.

COLLEGE NOTES.

Case School of Applied Science. The Faculty of Case School of Applied Science met at the home of President Howe on Friday evening, January 27, 1922, to discuss problems of teaching, carrying out the suggestion for local gatherings of President Scott. A temporary organization was provided with Professor W. R. Veazey, of the Department of Chemistry, presiding. A committee was appointed to nominate a permanent organization and to arrange for the next meeting. This committee consisted of Professor F. H. Neff, Professor R. C. Hummell, and Mr. R. C. Brett.

A very interesting and profitable discussion followed the presentation of informal talks on the following topics:

Some Principles of Good Teaching. Professor F. M. Comstock.

Does the Teaching of Juniors and Seniors differ from the Teaching of Freshmen and Sophomores? Professor F. H. Vose.

Specifications of a Good Engineering Teacher. Professor F. H. Neff.

Methods of Good Teaching in English. Professor K. O. Thompson.

Methods of Good Teaching in Modern Languages. Professor A. S. Wright.

The place of English and the responsibility of teachers in all departments for good English will be presented for further discussion at the next meeting.

Professor Dayton C. Miller completed a series of experiments on the subject of ether drift at the Mount Wilson Observatory in December, with somewhat inconclusive results. He presented a paper upon his work at the annual meeting of the American Physical Society in Toronto, in December. He was recently elected a non-resident vice-president of the Washington Academy of Sciences, and was

also appointed to the Committee on Relativity of the American Section of the International Astronomical Union.

University of Illinois. To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Not more than half of the time of a Research Graduate Assistant is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

University of Minnesota. By action of the Board of Regents, an Engineering Experiment Station and Bureau of Technological Research has been established. It is expected that the research work now carried on in the various departments will be correlated in the new Bureau which will also include the various investigations which are carried on in coöperation with the industries.

Plans are being prepared for a new Electrical Engineering building, which will cost about $300,000. It is hoped that the new building will be ready for use in the fall of 1923.

Through a new arrangement, the College of Engineering

and Architecture is to have supervision over the valuation work of the Minnesota Tax Commission as regards public service property. The School of Mines has had a similar relation for several years regarding mining property.

Swarthmore College student branches of the three national societies, American Institute of Electrical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, have recently been installed. These are conducted once each month in joint session, and visiting lecturers present talks of general engineering value. On the remaining Friday mornings some Junior or Senior engineering student presents a paper for discussion at each of the three simultaneous meetings.

Attendance is compulsory, the course being required under the name Conference, and one credit hour given. Much interest is shown and it seems like a solution of several problems.

Syracuse University. W. P. Graham, formerly Dean of the L. C. Smith College of Applied Science, has been appointed Acting Vice-Chancellor of the University.

Louis Mitchell, Professor of Civil Engineering, has been appointed Acting Dean of the L. C. Smith College of Applied Science. The appointment became effective in February, 1922.

Tulane University of Louisiana. Courses are undergoing a certain amount of reorganization in recognition of the principle that a four-years' course in engineering, whether it be in mechanical, electrical, civil, or chemical, will best meet the needs of the student by giving him a sound training in the fundamentals, rather than by attempting to teach him the practice of engineering through a number of highly specialized courses.

Freshmen in all the above courses take exactly the same

subjects—mathematics, English, chemistry, mechanical drawing and descriptive geometry and physical training. The subject of carpentry and pattern-making has been dropped and more time given to mathematics and drawing.

Mathematics and English are each continued for a full session in the sophomore year, chemistry is given another half session, and physics is taken for a year and a half in the sophomore and junior classes. All juniors in engineering take a course in economics, and all take the same course in mechanics of engineering and strength of materials.

In connection with the School of Marine Engineering, operated for the past several years here, the U. S. Shipping Board has loaned the College of Engineering a 2500 H. P. Westinghouse Marine Type Turbine with condenser and auxiliaries. Plans are under way for the installation of this turbine in the former carpenter shop, where it will be available for inspection and study, and some of the smaller auxiliaries will be arranged for operation in the laboratory of steam engineering.

Recent additions to the faculty are:

J. Herndon Thomson, associate professor of architecture, Cornell University, and for the past two years connected with the department of architecture at Clemson College, South Carolina.

Ivor O. Mall, assistant professor of mechanical engineering. Graduate of the Kansas State Agricultural College, instructor at University of Texas for two years.

Frederick H. Fox, assistant professor of civil engineering. Graduate of the University of Ohio, and formerly instructor at the Kansas State Agricultural College.

William P. Angel, assistant professor of physics. Graduate of the University of Tennessee and of Johns Hopkins University. Recently instructor in physics at the University of Pittsburgh.

Richard R. Kirk, assistant professor of English. Graduate

of the University of Michigan. Recently assistant professor at Georgia School of Technology.

Washington and Lee University. Under the auspices of the United Confederate Veterans a movement is now under way for the enlargement, equipment and endowment of the Washington and Lee engineering department as a Lee Memorial School of Engineering in honor of General Robert E. Lee who established the department in 1865.

Prof. William T. Lyle, of Houston, Texas, has been appointed professor of civil engineering and head of the engineering department. Prof. Hale Houston, of Clemson College, South Carolina, has been appointed associate professor of civil engineering. Both appointments became effective at the beginning of the present college year.

The policy of the department will be to provide a good all-around training such as is necessary to meet the demands of a modern practice which is recognizing more and more the inter-relationship of engineering enterprises and their mutual dependence.

Additional equipment is being purchased for materials testing, surveying and descriptive geometry. A course of lectures for the winter is being given on city planning. Attention is being paid to the enlargement of the instruction in highway, municipal, structural and water-power engineering. Courses in business law and money and banking are offered in the junior year and a new course in English is being designed for the senior year to meet the needs of the students in this department.

BOOK REVIEWS.

Masonry Structures. FREDERICK P. SPAULDING, Professor of Civil Engineering, University of Missouri. 404 pages, 6 × 9, 129 figures. Cloth $3.50 net. John Wiley & Sons, Inc.

This book is designed to present, in a brief and systematic manner, the fundamental principles involved in the design and construction of masonry structures, the term masonry being construed to include concrete, plain and reinforced as well as brick, terra cotta, and stone masonry. No attempt has been made to consider in detail all classes of masonry structures, the more important ones only being selected as most adequately illustrating the principles involved, and serving as an introduction to the subject. Chapters are devoted to the following subjects. Cementing materials, stone masonry, brick and block masonry, plain concrete, reinforced concrete, retaining walls, masonry dams, slab and girder bridges, masonry arches, culverts and conduits, and foundations. The explanations and discussions are clearly written and easily followed while the typography is such as to further render the text very readable. L. W. M.

Mechanism. R. McA. KEOWN, B.S. Published by McGraw-Hill Book Co. 170 pages, 6 × 9, 172 Illustrations. $2.25.

A thorough treatise from the point of view of mechanism of motions and velocities, instantaneous centers, linear velocities by instantaneous centers, velocity diagrams, parallel and straight line motion mechanisms, cams, friction and spur gearing, bevel and worm gearing, gear trains, belting, and intermittent motions. Numerous practical problems, both for class room and drafting room, serve to illustrate the subject matter. Definitions and rules are italicized to bring out the essential points. Cams are taken up considerably in detail with the object of developing originality in the student. The chapter on gearing is closed with a discussion on gear cutting. The practical side of the subject has been kept in mind rather than so much the theoretical. W. F. W.

Motor Truck Transportation. F. VAN Z. LANE, C. E., Lecturer in New York University. D. Van Nostrand Company. vi + 153 pages.

A pioneer work in an important field. The fifteen chapters deal with such topics as the future of the motor truck, the principles underlying operating costs, the relation of the motor truck to the horse and to the railroad, highway transport surveys and details of modern vehicle design and maintenance. Although an ardent advocate of the motor truck, the author presents his case fairly enough. The equation (p. 128),—"economical distribution = economical collection + economical transportation + economical marketing" sums up, in a way, the whole transportation problem, and might be taken as the keynote of the book. There is a valuable list of topics to be considered in making a highway transport survey. The illustrations are excellent, mainly photographs.

The final chapter, "Good Roads," is a plea for greater mileage and heavier construction. The fundamental economic considerations, however, which should control expenditures for road building are not given the attention they might have received. But on the whole, the book will be useful to those concerned with the problems of highway transport. For the class-room it must be supplemented by outside material, for both undergraduate and graduate courses. There is unfortunately no index nor list of illustrations. A future edition might also to advantage contain a bibliography.

C. J. T.

Loose Leaf Laboratory Manual No. 1, and No. 2. B. B. BURLING. Bruce Publishing Company No. 1, 25 report blanks 8¼ × 11—35 cents. No. 2, 24 report blanks 8¼ × 11—45 cents.

A laboratory manual intended for the use and guidance of the student when preparing and submitting reports on tests

performed in the study of science and elementary engineering. No. 1 is intended for tests in which the plotting of curves is not necessary for a complete understanding of the data and results. The two sides of each report blank are economically apportioned to all the essential elements of a report. No. 2 embodies all the parts of No. 1, with more space allotted the more important elements and in addition a page of standard 1 mm. cross-section paper for each report blank. These manuals encourage and facilitate the preservation of submitted reports and with an increase in space can be very profitably used in the preparation of all reports on engineering tests.

H. C. K.

Mechanics. JAMES E. BOYD, M.S., Professor of Mechanics, Ohio State University. 1st edition, 417 pages. 6″ × 9.″ McGraw-Hill Book Company.

A very complete textbook in mechanics for engineers. An unusual effort has been made to clarify the fundamental definitions, the explanations being supplemented by numerous examples. The explanations are very detailed and are supplemented by a variety of problems covering all of the details very thoroughly. The problems are quite largely theoretical and cover a wide range with regard to ease of solution, some requiring considerable thought. Only part of the answers are given. There are a large number of explanatory drawings. These are above the average both in execution and number. The order of presentation is quite logical, both graphical and analytical solutions being carried forward simultaneously. The definition and explanation of work and energy are given earlier in the text than usual. This text used in connection with the Strength of Materials by the same author should make a very complete and satisfactory course.

L. U. M.

CONFERENCE OF TEACHERS OF ENGLISH TO ENGINEERING STUDENTS.

The English Committee desires this year to get together at the Champaign meeting of the S. P. E. E. as large and representative a number as possible of the teachers of English to engineering students. The Committee feels that whatever the administrative relation of such teachers to the engineering college may be, they would appreciate and profit by an opportunity to get together, to meet each other and talk out thoroughly the problems which they have in common, and if possible to arrive at some general program for the development of their work. While the Committee plans to provide a program of really vital questions for discussion and to secure the presence of men whose experience in the teaching of English to technical students gives them authority to speak, it has been thought best to make the conference at Champaign a real round-table occasion, where, without the formality of prepared papers, everyone might have a chance to take part in the discussion.

The English Committee urges all teachers who are giving instruction in English to engineering students, whether they are members of the S. P. E. E. or not, to plan to be present. It also urges all deans and directors who are interested in securing more effective and inspiring work in English for their students to extend this invitation to the English teachers in their colleges and, wherever possible, to arrange for their attendance.

The conference will occur Friday morning, June 23, at 10 A.M. The topics for discussion will be announced later. Inquiries or suggestions may be meanwhile addressed to the chairman of the English Committee, Prof. J. Raleigh Nelson, College of Engineering and Architecture, Ann Arbor, Mich.